Deliverable Summary

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Context and Purpose

The measure “Stars: Automatic Enforcement of Traffic Lights” aims to demonstrate if and up to which level Intelligent Transport Systems (ITS) applied to traffic lights can improve the respect of road rules and, consequently, increase road safety.

With that purpose, the measure has been implemented by the Mobility Department of the Municipality of Bologna in collaboration with the Municipal Police Department.

By focussing only on economic consequences, as indicated within the Italian National Plan for Road Safety, the cost for a person dead in a street accident is estimated to be 1’394’434 Euros, while the cost for an injured person in a street accident is valued 73’631 Euros; it is estimated that road accidents impact on Italian gross national product for about 2%. Again the National Plan for Road Safety states that 83% of road accidents are caused by incorrect behaviour of road users and 35% of fatal accidents is due to speeding and jumping traffic lights also near pedestrian crossings. Indeed, the respect of rules assumes a decisive relevance when it is related to road safety and, consequently, to life saving.

In accordance with the National Plan for Road Safety, the Municipality of Bologna designed and approved the Urban Traffic Safety Plan, as part of the PGTU (Urban Traffic Plan). The Traffic Safety Plan suggests a set of integrated measures to be implemented in order to enhance road safety in Bologna, particularly to better

protect the weaker road users (i.e. pedestrians and cyclists). The plan foresees four categories, namely:

1. Traffic Engineering;
2. Protection of weak users;
3. Education – Making aware;
4. Control.

The STARS system fits within the fourth category (Control).

Summary Contents

STARS is a technological system for red light crossing control and automatic enforcement. It consists of a camera enclosed in a protective device placed closed to a junction to detect a violation and then issue a fine to vehicles crossing the intersection with the red light.

The procedure consists of the following steps:

- The camera takes photos of vehicles passing a junction when traffic light is red;
- The photos are sent to Municipal Police Department to be checked and validated by agents;
- The fines are automatically sent to lawbreakers;
- The fines and related photos have to be stored for both any legal complains (lawbreaker can ask for seeing the photos proving his/her illegal behaviour) and statistic appraisal.

From a technical view point, the camera is connected to traffic light hardware and special sensors, consisting of two sets of inductive loops placed few centimetres under the road pavement in correspondence to both the stop line and the middle of junction. Only when the traffic light turns to red the system starts working (as described in details in the following paragraph). When a vehicle passes with the red traffic light, sensors detect it and take two photos: one next to the stop line and the other by to the middle of junction. That's because the two photos are necessary to prove that the vehicle was passing with red light and not stationing in the middle of the junction for any reasons (e.g. due to traffic congestion).

Figure 1 and Figure 2 – *STARS: the system takes two photos of each vehicle passing while traffic light is red*

Additionally, with a precautionary approach, the Mobility Department decided to introduce some further features to the system, namely:

- A device allowing the system to activate itself not exactly when the traffic light switch on red, but after 0.5 seconds, in order to assure that only lawbreakers will be considered;
- For traffic lights equipped with STARS, the seconds of yellow light have been increased from 3 to 4;
- STARS is programmed to sanction only vehicles passing with a speed greater than 20 Km/h; that is in order, for example, to not fine vehicles going through the red traffic light to let pass an ambulance or another emergency vehicle;
- Even when it was not compulsory, well visible road signs have been put in correspondence of junctions equipped with STARS, to communicate the presence of that special enforcement system.

Such approach has guaranteed a very low rate of legal disputes compared with the number of issued fines. That is a very positive aspect for Bologna, considering the national scenario, where legal complaints on similar devices are very high and in some cases causes the total removal of the system.

In accordance with recommendations of the Traffic Safety Plan, the first STARS equipment has been implemented before the beginning of MIMOSA project by implementing an early experimental phase next to 4 crossings (7 camera facilities, each one controlling one direction); within MIMOSA, Bologna has intended to strengthen the system by performing:

a) Study and research activities;

b) Preparation of the equipment;

c) Enforcement activities;

d) Technical improvements and maintenance of the equipment;

e) Data collection campaigns for evaluation;

f) Information and dissemination activities.

a) Study and research activities

Moving forward from the Traffic Safety Plan conclusions, further research activities have been conducted to find the best locations for new STARS implementation.

A number of black spots have been defined within Bologna city network ("black spot" is a term used in road safety management to indicate a place where road traffic accidents are historically condensed): priority localizations (street intersections) have been identified in order to concentrate there interventions to promote road safety by installing a STARS system.

Priority criteria consisted in selecting the interventions that could guarantee at the same time:

i) the greater possible reduction of the accidents with fatalities;

ii) the greater possible reduction of the total number of fatalities and injuries.

b-c) Equipment preparation and enforcement activities

New cameras have been installed and new crossroads equipped by activating 20 new camera facilities (each one controlling one direction at the junction), connecting them to traffic light hardware, installing sensors. After a short testing period, the enforcement activity started on new STARS facilities. Today STARS system controls 27 directions on 15 junctions.

d) Improvement and maintenance of the equipment

Maintenance activity has been necessary on both the system itself and on-street cameras: this activity appeared to be really resource-consuming (in some cases even beyond expectations), and it will go along all through the measure duration.

In the second year of the project, for instance, the Municipality of Bologna experienced some problems dealing with maintenance due to sensors breaking in occasion of civil works in some junctions. Additionally, even if maintenance activities have been carried out during the whole third year of the project, some sensors are still in reparation.

e) Data collection for evaluation

Data have been collected to proceed with the measure evaluation assessment, in particular with reference to two impact indicators:

- number of accidents and severe injuries registered on STARS controlled crossings (the most important impact evaluation indicator).

- number of fines for road crossings controlled by STARS, used to compare the before scenario – where fines manually imposed by traffic policeman – with the after scenario – in which the system is in operation and fines are directly issued by STARS system, and extrapolate some trends.

f) Information and dissemination activities

Since the measure implementation could have a considerable impact on drivers (e.g. fines for illegal traffic light trespassing, beside the economic consequences for the lawbreaker, caused also a credits removal of his/her driving license), and in order to guarantee the higher level of transparency, an adequate communication campaign has been ensured:

- in occasion of the second phase of STARS implementation (within MIMOSA),

the new system has been officially presented to media. The press conference took place directly on streets and was handled by the former Mayor Councillor of Urban Mobility.

Figure 3 – STARS have been officially presented to media

- the exact locations of STARS system have been represented on the map produced and distributed by the Municipality of Bologna to citizens to inform and describe measures carried out to improve traffic and urban mobility. The map is available also for downloading at http://www.comune.bologna.it/media/files/qualit_dellaria_20112012.pdf;

- a STARS system dedicated web page has been created on the official Mobility Department website to describe the system and inform citizens about the exact location of crossroads equipped: http://www.comune.bologna.it/trasporti/servizi/2:3413/3292/ ;

- the STARS system functionality and first results obtained have been described and showed in occasion of several local and international meetings and conferences.

Functional Use

The purpose of the present Deliverable is to give an overview of the efforts undertaken by the Municipality of Bologna (Mobility Department) in collaboration with the Municipal Police Department to implement an innovative ITS (STARS) system aiming to control and automatically fine vehicles illegally crossing at the red light.

At the present stage of the measure, the equipment installation is already concluded and enforcement activity runs at full scale. Data for a first evaluation assessment have already been collected and some findings are anticipated in this document.

Lessons learned

As previously described, evaluation activity is considering all STARS equipped junctions investigating two impact indicators. Even if the final outcomes will be available only when the evaluation activity will be concluded, but some conclusions can be already drafted, and some lessons learnt illustrated.

a) number of accidents and severe injuries registered on junctions equipped with STARS

This impact indicator could be considered the most important one because it is directly linked with road safety issue.

Numbers in the following chart indicate accidents and severe injuries occurred considering all crossings equipped with STARS system. Comparison is made considering both the year after STARS activation (for each equipped crossing) and the year before against August 2010 (last available data gathering).

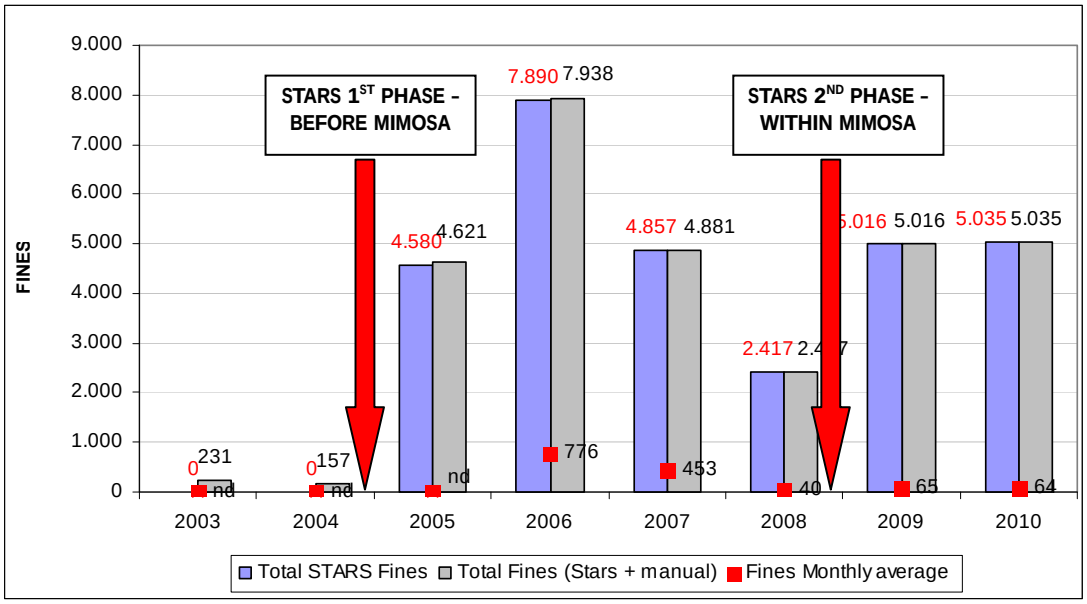
ALL CROSSINGS EQUIPPED WITH STARS	Difference between the situation before and one year after STARS activation	Δ%	Difference between the situation before STARS activation and in August 2010	Δ%
TOTAL ACCIDENTS	**- 29**	**- 34,52%**	**-37**	**- 44,05%**
TOTAL INJURES	**- 59**	**- 43,07%**	**-66**	**- 48,18%**

As already mentioned, final outcomes will be available only when the evaluation activity will be concluded. Nevertheless, by considering these indicators some conclusions can be anticipated:

- considerable effects in terms of accidents and severe injured people reduction have been registered even on the period very closed to the beginning of STARS implementation;
- such a positive results have even increased later;
- indeed STARS seems to have a quite significant impact on road safety at crossroads and such an impact could be considered stable. A reduction of about 45% in terms of accidents and severe injuries can be considered a brilliant result.

b) number of fines for road crossings controlled by STARS

As illustrated in the figure below, we have compared the fines imposed by STARS system after its activation (blue histogram) and total fines imposed both manually by traffic policemen and by STARS system when active (grey histogram). The red dots indicate the average number of fines imposed on a single junction (both manually or through STARS), on a monthly base.



Trend of fines can be described as follow:

- the number of fines dramatically increased after the first installation (happened before the beginning of MIMOSA project) from 2004 when all fines were imposed only manually, to 2005 with the first STARS system implemented and automatic enforcement activated;
- fines imposed by the STARS system increased also in 2006, that was the year when the maximum number of fines was registered, despite the low number of equipped crossroads;
- after 2006 the number of fines strongly decreased up to 2008;
- at the end of 2008 the 2nd phase of STARS implementation was realised and during the following years the number of fines increased again, but without reaching the pick level of 2006;
- since the number of STARS systems active after 2008 is considerable higher than before, it is better to consider the number of fines imposed on average by each STARS system. In this way it has been possible to perceive that the number of fines issued by each STARS system remained quite stable after the 2nd phase of implementation;
- the number of fines seems to have reached a level of stability between 2009 and 2010, but it is necessary to wait for further data in order to evaluate if the trend has really become stable or not.

As already mentioned, final outcomes will be available only when the evaluation will be concluded, but trend of number of registered fines till now shows that:

- traditional control by Police Department is able to fine only a minor part of violations, proving the effective impossibility of the human control to cover all infractions and consequently the importance of introducing an automatic enforcement system such as STARS;

- after an initial period of fine-tuning when the system was initially introduced (suddenly number of fines radically increased), the drivers behaviour improved (average number of fines dramatically decreased), proving the effectiveness of STARS system to motivate drivers towards a different and safer behaviour at crossroads.

c) Conclusions

In conclusion, the STARS system introduction positively influenced drivers behaviour at traffic lights junctions by increasing the respect of road rules and therefore road safety.

Due to the measure success, the Municipality of Bologna in collaboration with Municipal Police Department are considering the possibility to further extend the number of junctions equipped with STARS system by identifying the next junctions with higher number of accidents.

Despite the positive results obtained, technicians have to consider a potential side-effect before taking the final decision: potential up scaling of this measure (i.e. installing cameras in much more crossroads) could actually not necessarily improve road safety.

Certainly after the first implementation it has been registered a drivers behaviour improvement, even in junctions where the enforcement system was not present. Then good results could be achieved just covering the main black spots.

On the contrary, extending the junctions enforcement in hundreds of crossroads could generate problems in terms of system acceptability and perception of Administration punishment attitude (this situation has been faced by other Municipalities and the discussion about the enforcement system acceptance is currently on top all over Italy).

The question is still open and the political point of view will be decisive.

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